

FINAL REPORT

**Design of Sensors for Control of Closed Loop Life Support Systems**

to the

National Aeronautics and Space Administration  
and the  
Universities Space Research Association

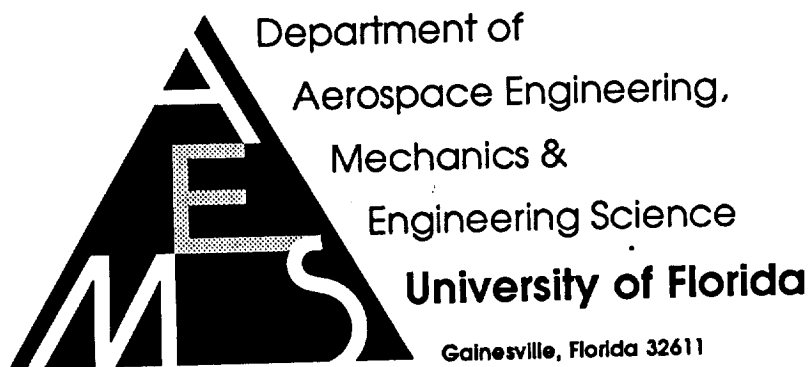
describing

1989-1990 University of Florida Participation

in the

NASA\USRA Advanced Design Program

July 1990



(NASA-CR-136656) DESIGN OF SENSORS FOR  
CONTROL OF CLOSED LOOP LIFE SUPPORT SYSTEMS  
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Instructor

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## ACKNOWLEDGEMENTS

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## INTRODUCTION

For a number of years the eight semester credit Engineering Design sequence, EGM 4000/4001, has been project oriented and taught by Dr. Gale E. Nevill, Jr. on a cooperative basis with representatives of industry and various government agencies and laboratories. For the past five years this sequence has been taught in cooperation with personnel from the NASA/KSC/CELSS project with support from a NASA/USRA Advanced Space Design Program grant. This year the cooperation has continued as the University of Florida has assumed Sustaining status in the Advanced Design Program.

Planning for this year's course took place in the spring and summer of 1989 with discussions between Dr. Nevill and Mr. Ken Anderson of the University of Florida and Mr. Jim Aliberti, Mr. Ralph Prince, Dr. John Sager and Dr. William Knott of NASA/KSC. The course began with a presentation to the class in Gainesville by Messrs. Knott, Sager and Prince regarding the nature and needs of the NASA/KSC Controlled Environmental Life Support System (CELSS) program. Communication between class members and KSC personnel was maintained by frequent telephone contact and regular visits by KSC personnel to the University campus. In addition to the informal visits, KSC personnel also were present for formal oral presentations of achievements at the end of each semester. Communication was also strengthened by a class visit to KSC in the Spring semester of 1990. This provided an opportunity for a general tour of KSC, for a more detailed familiarization with the CELSS project and for personal meetings with several CELSS project personnel who had not been to campus.

During the first semester (EGM 4000) focus was on learning general principles and techniques of design, both through work on the main class project and a number of smaller "over the weekend" type projects. The instructor served as project leader during the very early part of the semester; later students served as project and group leaders on a rotating basis, thus giving all class members an opportunity for some leadership experience.

During the second semester (EGM 4001), focus was on learning to design, actually fabricate and test small components and subsystems, thus adding considerable realism to the students experience. The students were responsible for planning and managing each of the projects initiated and for making regular oral progress reports, submitting regular written progress reports, presenting a final oral briefing and preparation of a comprehensive final written project report. During the latter part of the semester Mr. Bill Martin of KSC replaced Jim Aliberti as the principal KSC administrative contact and was able to attend the final project presentation along with a number of other KSC and Bionetics personnel.

## DESIGN PROJECT DESCRIPTIONS

During the first semester the class focused first on the sensing and control needs of a regenerative system for growing higher plants in space during long duration missions. Effort was devoted to clarifying system requirements, to organizing and conducting the learning required by the project, and to identifying promising specific project areas. The class was then divided into five teams which explored and did preliminary design studies on sensing and control of (1) atmosphere and temperature, (2) nutrient delivery system, (3) plant health, (4) plant propagation, and (5) solids processing. The results of the first semesters work are presented in the EGM 4000 class final report, dated December 1989, titled Design and Implementation of Sensor Systems for Control of a Closed-Loop Life Support System which is included as Appendix A.

The work of the first semester clarified the five design problem areas and provided the basis for choosing projects for the second semester. For the second semester, three of these areas were selected as most promising for detail component design, prototype fabrication and testing. In addition, students became interested in the use of artificial neural networks as controllers and a network project was added. The second semester design projects chosen were:

- seed moisture content sensor,
- porous medium wetness sensor,
- plant health monitoring sensor, and
- neural network controller.

The students were divided into four groups and each group, developed design specifications, created a detailed design to satisfy the specifications (in most cases created numerous designs), and built prototypes and tested them. The results of these efforts are described in the EGM 4001 class second semester report, dated May 1990, titled Implementation of Sensor and Control Designs for Bioregenerative Systems which is included as Appendix B.

## SUMMARY

The 1989/90 EGM 4000/4001 Engineering Design course, with enthusiastic cooperation from NASA/KSC personnel and support from the USRA/University Advanced Space Design Program, was clearly successful. In this course the students were provided with a highly motivating opportunity for in-depth involvement in a real, complex and important design problem. They benefitted from extensive interaction with NASA professional and technical personnel and had opportunities to visit NASA Centers and broaden their technical and professional horizons. The students were able to develop a sound working knowledge of design principles and methodologies, gain project organization and leadership experience under realistic conditions, develop skills at oral presentation and report writing and learn about the realities of trying to actually fabricate a working prototype of a design. Finally, they were able to obtain the maturity, self-confidence and satisfaction of doing professional level technical work.

NASA also is believed to have benefitted significantly from this cooperative venture, by the strengthening of the design capabilities of a number of promising students, by contact with and close knowledge of a number of potential professional employees and by a number of promising insights and novel design concepts relevant to the NASA/KSC/CELSS program. Overall, this program is considered to have been highly successful, and well worth the resources invested in it.